ATTACHED ARE:

1) A transcribed copy of BAA 99-20 as it appeared in the *Commerce Business Daily* (CBD) of January 15, 1999 and

2) the BAA 99-20 Proposer Information Pamphlet.

Due to the possibility of transcription errors, the official CBD announcement takes precedence over this transcription in any disagreement between the two. The transcription is provided for your convenience only.

SOFTWARE FOR DISTRIBUTED ROBOTICS SOL 99-20 DUE 04/07/99 POC Dr. Mark L. Swinson, DARPA/ITO, FAX: (703-522-7161) WEB: http://www.darpa.mil/ito/Solicitations.html. E-MAIL: baa99-20@darpa.mil.

Software for Distributed Robotics (SDR) will enable the employment of groups of cooperating, mobile robots which, when working collectively, can accomplish useful objectives in realistic, operational environments. Software research is sought which will augment the ongoing DARPA program in the Electronic Technology Office (ETO) known as Distributed Robotics (DR).

Current mobile robots are comparatively large, employing fairly conventional components and subsystems for mobility, power, sensing, actuation, communication and computation. In contrast, the Distributed Robotics program is pursuing revolutionary technologies driven by severe form factor constraints, since conventional components and subsystems generally do not scale down to the dimensions required. Potential military applications for such micro-miniature devices include surveillance, reconnaissance, hazard detection, pathfinding, payload conveyance, and small-scale actuation.

A key tenet of the Software for Distributed Robotics program is that the actions of large numbers of small scale robots can be coordinated so as to achieve large scale results. Realization of this goal will require novel software technology to achieve the required level of coordinated group behavior. Additionally, the severe form factor constraints and the consequent impact on available resources will have significant implications. For example, power constraints effectively preclude the use of conventional implementations of network protocols. Similarly, onboard computational capacity is limited. Hence, the Software for Distributed Robotics research challenge is to develop solutions that achieve the desired functional capabilities while overcoming the limitations of both the on-board processors and the data communications network.

Proposals should identify which of the following alternative approaches their proposal most closely matches. The alternatives, which are referred to as technical topic areas for the purpose of this solicitation, are:
1. distributed processing;

2. proxy processing;
3. or other.

Irrespective of the approach chosen, each proposal must describe how the performers' software solution will realize the following capabilities:
1. the reprogrammable, coordinated control of a networked group of extremely small, mobile robots;
2. and convincing laboratory demonstration of the software solution on a collection of surrogate, mobile robot platforms.

The laboratory demonstrations will be conducted using one or more types of small, commercially available, mobile robots. The final demonstration for the base effort must include at least ten robots operating collectively in a manner that is functionally representative of how the software would be employed on the Distributed Robotics platforms under development within ETO.

Proposals should include an optional task of migrating their software to government-designated platforms and conducting field demonstrations. Proposals should be for a base effort of 27 months (including the laboratory demonstrations), with two 12-month options to continue development as well as to extend the effort by migrating the developed software to government designated, mobile robot platforms for field. Research with a hardware component is not within the scope of this solicitation. Similarly, research on software-only systems (knowbots) as well as research focused on physically embodied agents, but which is to be conducted entirely in computer simulation, is also not within the scope of this solicitation.

PROGRAM SCOPE:

Proposed research should investigate innovative approaches and techniques that lead to or enable revolutionary advances in the state-of-the-art. Proposals are not limited to the specific strategies listed above and alternative visions will be considered. However, proposals should be for research that substantially contributes towards the goals stated. Research should result in prototype hardware and/or software demonstrating integrated concepts and approaches. Specifically excluded is research that primarily results in evolutionary improvement to the existing state of practice or focuses on a specific system or solution. Integrated solution sets embodying significant technological advances are strongly encouraged over narrowly defined research endeavors. Proposals may involve other research groups or industrial cooperation and cost sharing.

GENERAL INFORMATION:

In order to minimize unnecessary effort in proposal preparation and review, proposers are strongly encouraged to submit brief proposal abstracts in advance of full proposals. An original and nine copies of the proposal abstract must be submitted to DARPA/ITO, ATTN: BAA 99-20, 3701 North Fairfax Drive, Arlington, VA 22203-1714, in time to reach DARPA by 4:00 PM (ET), Monday, February 22, 1999, to guarantee review. Upon

review, DARPA will make a recommendation to offerors either encouraging or discouraging submission of full proposals.

Proposers must submit an original and nine copies of full proposals in time to reach DARPA by 4:00 PM (ET), Wednesday, April 7, 1999, in order to be considered. Proposers must obtain a pamphlet, BAA 99-20 Proposer Information, which provides further information on the areas of interest, submission, evaluation, funding processes, proposal abstracts, and full proposal formats. This pamphlet may be obtained by fax, electronic mail, or mail request to the administrative contact address given below, as well as at URL address http://www.darpa.mil/ito/Solicitations.html. Proposals not meeting the format described in the pamphlet may not be reviewed. This Commerce Business Daily notice, in conjunction with the pamphlet BAA 99-20 Proposer Information, constitutes the total BAA. No additional information is available, nor will a formal RFP or other solicitation regarding this announcement be issued. Requests for same will be disregarded.

The Government reserves the right to select for award all, some, or none of the proposals received.

All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA. Historically Black Colleges and Universities (HBCU) and Minority Institutions (MI) are encouraged to submit proposals and join others in submitting proposals. However, no portion of this BAA will be set aside for HBCU and MI participation due to the impracticality of reserving discrete or severable areas of this research for exclusive competition among these entities.

Evaluation of proposals will be accomplished through a scientific review of each proposal using the following criteria, which are listed in descending order of relative importance:
(1) overall scientific and technical merit,
(2) potential contribution and relevance to DARPA mission,
(3) offeror's capabilities and related experience,
(4) plans and capability to accomplish technology transition, and
(5) cost realism.

All administrative correspondence and questions on this solicitation, including requests for information on how to submit a proposal abstract or proposal to this BAA, must be directed to one of the administrative addresses below by 4:00 PM (ET), Wednesday, March 31, 1999; e-mail or fax is preferred. DARPA intends to use electronic mail and fax for some of the correspondence regarding BAA 99-20. Proposals and proposal abstracts may not be submitted by fax; any so sent will be disregarded.

The administrative addresses for this BAA are:

Fax: 703-522-7161 Addressed to: DARPA/ITO, BAA 99-20
Electronic Mail: baa99-20@darpa.mil

Electronic File Retrieval: http://www.darpa.mil/ito/Solicitations.html
Mail: DARPA/ITO
ATTN: BAA 99-20
3701 North Fairfax Drive Arlington, VA 22203-1714

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BAA 99-20 PROPOSER INFORMATION PAMPHLET

The Defense Advanced Research Projects Agency (DARPA) often selects its research efforts through the Broad Agency Announcement (BAA) process. The BAA will appear first in the *Commerce Business Daily*, published by the U.S. Government, Department of Commerce. The following information is for those wishing to respond to the Broad Agency Announcement.

SOFTWARE FOR DISTRIBUTED ROBOTICS SOL BAA 99-20 DUE 4/7/99 POC Dr. Mark L. Swinson, DARPA/ITO, FAX: (703) 522-7161

Software for Distributed Robotics (SDR) will enable the employment of groups of cooperating, mobile robots which, when working collectively, can accomplish useful objectives in realistic, operational environments. Software research is sought which will augment the ongoing DARPA program in the Electronic Technology Office (ETO) known as Distributed Robotics (DR).

Current mobile robots are comparatively large, employing fairly conventional components and subsystems for mobility, power, sensing, actuation, communication and computation. In contrast, the Distributed Robotics program is pursuing revolutionary technologies driven by severe form factor constraints, since conventional components and subsystems generally do not scale down to the dimensions required. Potential military applications for such micro-miniature devices include surveillance, reconnaissance, hazard detection, pathfinding, payload conveyance, and small-scale actuation.

A key tenet of the Software for Distributed Robotics program is that the actions of large numbers of small scale robots can be coordinated so as to achieve large scale results. Realization of this goal will require novel software technology to achieve the required level of coordinated group behavior. Additionally, the severe form factor constraints and the consequent impact on available resources will have significant implications. For

example, power constraints effectively preclude the use of conventional implementations of network protocols. Similarly, onboard computational capacity is limited. Hence, the Software for Distributed Robotics research challenge is to develop solutions that achieve the desired functional capabilities while overcoming the limitations of both the on-board processors and the data communications network.

Proposals should identify which of the following alternative approaches their proposal most closely matches. The alternatives, which are referred to as technical topic areas for the purpose of this solicitation, are:

1) distributed processing;
2) proxy processing; or
3) other.

Irrespective of the approach chosen, each proposal must describe how the performers' software solution will realize the following capabilities:

1) the reprogrammable, coordinated control of a networked group of extremely small, mobile robots; and
2) convincing laboratory demonstration of the software solution on a collection of surrogate, mobile robot platforms.

The laboratory demonstrations will be conducted using one or more types of small, commercially available, mobile robots. The final demonstration for the base effort must include at least ten robots operating collectively in a manner that is functionally representative of how the software would be employed on the Distributed Robotics platforms under development within ETO. Proposals should include an optional task of migrating their software to government-designated platforms and conducting field demonstrations.

Proposals should be for a base effort of 27 months (including the laboratory demonstrations), with two 12-month options to continue development as well as to extend the effort by migrating the developed software to government designated, mobile robot platforms for field. Research with a hardware component is not within the scope of this solicitation. Similarly, research on software-only systems (knowbots) as well as research focused on physically embodied agents, but which is to be conducted entirely in computer simulation, is also not within the scope of this solicitation.

TECHNICAL TOPIC AREAS:

In all cases proposals must exhibit science-based approaches that are well grounded in the underlying physical and mathematical principles. Proposals are sought in the following topic areas:

1. Distributed Processing – processing is predominantly performed on-board the robots.

Distributed processing seeks to minimize the reliance on off-robot, (proxy) processing capabilities by allocating nearly all of the computational load to the processors on-board the robots.

2. Proxy Processing – processing is predominantly performed off-board the robots.

Proxy processing seeks to minimize the requirement for computational capability on-board the robots, by allocating nearly all of the computational load to more capable, off-robot, data processing resources.

3. Other.

CAPABILITY AREAS:

Proposals must describe how they will realize all of the following capabilities:

1. A software solution that enables the reprogrammable, goal-directed control of a networked group of extremely small, mobile robots which are collaborating to perform a collective task while exhibiting context appropriate, sensor-based interaction with their environment.

   This program is focused on enabling the use of many small robots which, though individually very limited in capability, can collectively perform useful missions. These collective behaviors must be deliberate and predictable, at least in the large. Additionally, as these robots must be able to perform in dynamic, unstructured environments, the individual robots must also exhibit context appropriate, sensor-mediated (reactive/reflexive) behaviors. Distributed Robotics devices are resource constrained (especially power) due to the extremely restrictive form factors that usually define these systems, consequently proposals must consider computational power as a limited resource. Similarly, the data communications strategies and implementations of networking protocols must account for and be consistent with these limitations. Proposed solutions must also be scaleable, and support dynamic population membership, since the number of individuals (as well as member identities) may rapidly change over the course of a mission. Solutions must account not only for data transfer in support of robot mobility and navigation, but also for information transfer in support of payload operations, especially sensor payloads.

2. Convincing laboratory demonstration of the software solution on a collection of surrogate, mobile robot platforms.

   Proposals must include a discussion of how they will demonstrate the required software (including at least one interim laboratory demonstration by the end of the first year and one final demonstration by the end of the second year of the base effort) on a collection of contractor furnished mobile robots. Any of the various small (roughly palm size or smaller), commercially available, mobile robot

platforms may be used. The final demonstration of the base effort must employ a minimum of ten robots (of one or more types), with the software integrated into and controlling the robots, and convincingly demonstrate that the recommended solution will be suitable for the objective, Distributed Robotics devices. Proposals should describe the metrics and methodology by which the preceding capabilities will be evaluated in the context of the demonstration. Proposals should also include an option for the performer to migrate the developed software to government designated, mobile robot platforms for field demonstrations.

PROGRAM SCOPE:

Proposed research should investigate innovative approaches and techniques that lead to or enable revolutionary advances in the state-of-the-art. Proposals are not limited to the specific strategies listed above and alternative visions will be considered. However, proposals should be for research that substantially contributes towards the goals stated. Research should result in prototype hardware and/or software demonstrating integrated concepts and approaches. Specifically excluded is research that primarily results in evolutionary improvement to the existing state of practice or focuses on a specific system or solution. Integrated solution sets embodying significant technological advances are strongly encouraged over narrowly defined research endeavors. Proposals may involve other research groups or industrial cooperation and cost sharing. Please note that this BAA is sponsored by the DARPA Information Technology Office (ITO), but also affects the DARPA Electronics Technology Office (ETO) as indicated herein.

SUBMISSION PROCESS:

Proposers are strongly encouraged to submit a proposal abstract in advance of actual proposals. This procedure is intended to minimize unnecessary effort in proposal preparation and review. An original and nine copies of the proposal abstract must be submitted to DARPA/ITO, ATTN: BAA 99-20, 3701 North Fairfax Drive, Arlington, VA 22203-1714, in time to reach DARPA by 4:00 PM (ET), Monday, February 22, 1999, to guarantee review. An original and nine copies of each proposal must be submitted to the administrative address for this BAA in time to reach DARPA by 4:00 PM (ET), Wednesday, April 7, 1999, in order to be considered. DARPA will acknowledge receipt of submissions and assign control numbers that should be used in all further correspondence regarding abstracts and proposals.

DARPA will attempt to review proposal abstracts within 20 days after receipt and will make a recommendation encouraging or discouraging formal proposal submissions. Proposal abstracts will be reviewed as they are received. Early submissions are strongly encouraged. Regardless of the recommendation, the decision to propose is the responsibility of the proposer. All submitted proposals will be fully reviewed regardless of the disposition of the proposal abstract.

The typical proposal should express a consolidated effort in support of one or more technical topic areas. Disjoint efforts should not be included in a single proposal.

Restrictive notices notwithstanding, proposals may be handled, for administrative purposes only, by a support contractor. This support contractor is prohibited from competition in DARPA technical research and is bound by appropriate non-disclosure requirements.

EVALUATION AND FUNDING PROCESSES:

Proposals will not be evaluated against each other since they are not submitted in accordance with a common work statement. DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons. For evaluation purposes, a proposal is the document described in PROPOSAL FORMAT Section I and Section II (see below). Other supporting or background materials submitted with the proposal will be considered for the reviewer's convenience only and not considered as part of the proposal.

Evaluation of proposals will be accomplished through a scientific review of each proposal using the following criteria, which are listed in descending order of relative importance:
(1) overall scientific and technical merit,
(2) potential contribution and relevance to DARPA mission,
(3) offeror's capabilities and related experience,
(4) plans and capability to accomplish technology transition, and
(5) cost realism.

Proposals may be reviewed by non-government personnel; however, contractors will not be used to conduct evaluations or analyses of any aspect of a proposal submitted under this BAA unless one of the three conditions identified in FAR 37.203(d) applies.

As soon as the proposal evaluation is completed, the proposer will be notified of selectability or non-selectability. Selectable proposals will be considered for funding; non-selectable proposals will be destroyed. (Copies of non-selectable proposals may be retained for filing purposes.) Not all proposals deemed selectable will be funded. Decisions to fund selectable proposals will be based on funds available, scientific and technical merit, and potential contribution and relevance to DARPA's mission and offeror’s capabilities and expertise. DARPA may retain some selectable proposals for a period of up to one year in order to reconsider those proposals for funding. Submitters of those retained proposals will receive notification to that effect.

The Government reserves the right to select for award all, some, or none of the proposals received. Proposals identified for funding may result in a contract, grant, cooperative agreement, or other transaction depending upon the nature of the work proposed, the required degree of interaction between parties, and other factors. If warranted, portions of resulting awards may be segregated into pre-priced options.

GENERAL INFORMATION:

Proposals not meeting the format described in this pamphlet may not be reviewed. Proposals and proposal abstracts may not be submitted by fax; any so sent will be disregarded. The *Commerce Business Daily* notice, in conjunction with this pamphlet, BAA 99-20 Proposer Information, constitutes the total BAA. No additional information is available, nor will a formal RFP or other solicitation regarding this announcement be issued. Requests for same will be disregarded. All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA. Historically Black Colleges and Universities (HBCU) and Minority Institutions (MI) are encouraged to submit proposals and join others in submitting proposals. However, no portion of this BAA will be set aside for HBCU and MI participation due to the impracticality of reserving discrete or severable areas of this research for exclusive competition among these entities.

PROPOSAL ABSTRACT FORMAT:

Proposal abstracts are encouraged in advance of full proposals in order to provide potential offerors with a rapid response and to minimize unnecessary effort. The abstract submission should be clearly marked "PROPOSAL ABSTRACT" and should include a cover sheet and a technical section.

The cover sheet should include: (1) BAA number; (2) Technical topic area; (3) Proposal title; (4) Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (5) Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (6) Summary of the costs of the proposed research, including total base cost, estimates of base cost in each year of the effort, estimates of itemized options in each year of the effort, and cost sharing if relevant; and (7) Contractor's type of business, selected from among the following categories: "LARGE BUSINESS," "SMALL DISADVANTAGED BUSINESS," "OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," or "OTHER NONPROFIT."

The technical section of the abstract should include the following: A. {1 page} Innovative claims for the proposed research. This page is the centerpiece of the abstract and should succinctly describe the unique proposed contribution; and B. {4 pages} Technical rationale, technical approach and constructive plan for accomplishment of technical goals in support of innovative claims and deliverable products. Include comparison with other ongoing research indicating advantages and disadvantages of the proposed effort.

The total length of the abstract should not exceed six pages including the cover sheet. Proposal abstracts ONLY (not proposals) may alternatively be submitted via electronic mail to baa99-20@darpa.mil. E-mail submissions must be formatted as plain ASCII, 72 characters to the line, 60 lines to the page. This is the only format that will be accepted. No formal transmittal letter is required.

PROPOSAL FORMAT:

Proposals shall include the following sections, each starting on a new page (where a "page" is 8-1/2 by 11 inches with type not smaller than 12 point) and with text on one side only. The submission of other supporting materials along with the proposal is strongly discouraged. Sections I and II of the proposal shall not exceed 40 pages. Maximum page lengths for each section are shown in braces {} below.

Section I. Administrative

{1} Cover Page including: (1) BAA number; (2) Technical topic area; (3) Proposal title; (4) Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (5) Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (6) Summary of the costs of the proposed research, including total base cost, estimates of base cost in each year of the effort, estimates of itemized options in each year of the effort, and cost sharing if relevant; and (7) Contractor's type of business, selected from among the following categories: "LARGE BUSINESS," "SMALL DISADVANTAGED BUSINESS," "OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," or "OTHER NONPROFIT."

Section II. Detailed Proposal Information

This section provides the detailed discussion of the proposed work necessary to enable an in-depth review of the specific technical and managerial issues. Specific attention must be given to addressing both risk and payoff of the proposed work that make it desirable to DARPA.

A. {1} Innovative claims for the proposed research. This page is the centerpiece of the proposal and should succinctly describe the unique proposed contribution.

B. {18} Technical rationale, technical approach and constructive plan for accomplishment of technical goals in support of innovative claims and deliverables.

C. {2} Deliverables associated with the proposed research. Include in this section all proprietary claims to results, prototypes, or systems supporting and/or necessary for the use of the research, results, and/or prototype. If there are no proprietary claims, this should be stated. The offeror must submit a separate list of all technical data or computer software that will be furnished to the Government with other than unlimited rights (see DFARS 227.)

D. {3} Statement of Work (SOW) written in plain English, outlining the scope of the effort and citing specific tasks to be performed and specific contractor requirements.

E. {1} Schedule of milestones for the proposed research.

F. {2} Technology Transfer. Description of the transferable technology and expected technology transfer path.

G. {3} Comparison with other ongoing research indicating advantages and disadvantages of the proposed effort.

H. {3} List of key personnel, concise summary of their qualifications, and discussion of proposer's previous accomplishments and work in this or closely related research areas. Indicate the level of effort to be expended by each person during each contract year and other (current and proposed) major sources of support for them and/or commitments of their efforts. DARPA expects all key personnel associated with a proposal to make substantial time commitment to the proposed activity.

I. {1} Description of the facilities that would be used for the proposed effort.

J. {5} Cost by task, with breakdown into accounting categories and equipment for the entire contract and for each contract year. Where the effort consists of multiple portions that could reasonably be partitioned for purposes of funding, these should be identified as contract options with separate cost estimates for each. Details of any cost sharing should also be included. Budgets for Government furnished/funded equipment should be limited to experimental apparatus and exclude office and laboratory equipment normally associated with Information Technology research environments, such as servers, workstations, PCs, laptops, PDAs, routers, printers, copiers, fax machines, etc.

Awards made under this BAA may be subject to the provisions of the Federal Acquisition Regulation (FAR) Subpart 9.5, Organizational Conflict of Interest. All offerors and proposed subcontractors must affirmatively state whether they are supporting any DARPA technical office(s) through an active contract or subcontract. "Support contract" or "support contractor" includes a contract or subcontract for acquisition of System Engineering and Technical Assistance (SETA) services, and other support service contracts in which any one of the following situations apply: have personnel who regularly maintain offices or frequently occupy space within DARPA; maintain external spaces in which DARPA personnel maintain offices or frequently occupy; or have personnel with any access to the DARPA fiscal database, EIS, or contractual or programmatic documentation related to other than their own contact(s). All affirmations must state which office(s) the offeror supports, and identify the prime contract number. Affirmations should be furnished at the time of proposal submission. All facts relevant to the existence or potential existence of organizational conflicts of interest, as that term is defined in FAR 9.501, must be disclosed in Section II., H of the proposal, organized by task and year. This disclosure shall include a description of the action the Contractor has taken, or proposes to take, to avoid, neutralize, or mitigate such conflict.

Section III. Additional Information

A bibliography of relevant technical papers and research notes (published and unpublished) that document the technical ideas upon which the proposal is based. Copies of not more than three relevant papers may be included in the proposal submission; provide one set for the original proposal and one set for each of the nine proposal copies. Please note: the materials listed in Section III. Additional Information, and submitted with the proposal, will be considered for the reviewer's convenience only and not considered as part of the proposal for evaluation purposes.

Additional Electronic Submission Encouraged

In ADDITION to the paper proposals, proposers are strongly encouraged to send ASCII text electronic copies of the statement of work and equipment needs to the following email address: baa99-20@darpa.mil. The title of the proposal and the name of the proposing organization must be provided as a header to enable administrative staff to match these electronic submissions with the full proposals. The statement of work and equipment budgets must be identical (except for format) to the statement of work in the full proposal.

The administrative addresses for this BAA are:

Fax: 703-522-7161 Addressed to: DARPA/ITO, BAA 99-20
Electronic Mail: baa99-20@darpa.mil
Electronic File Retrieval: http://www.darpa.mil/ito/Solicitations.html
Mail: DARPA/ITO
ATTN: BAA 99-20
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